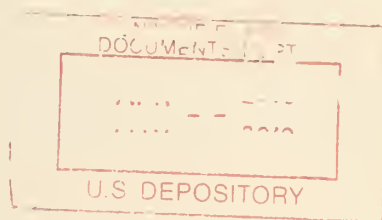


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GLUES FOR USE IN AIRCRAFT

October 1941



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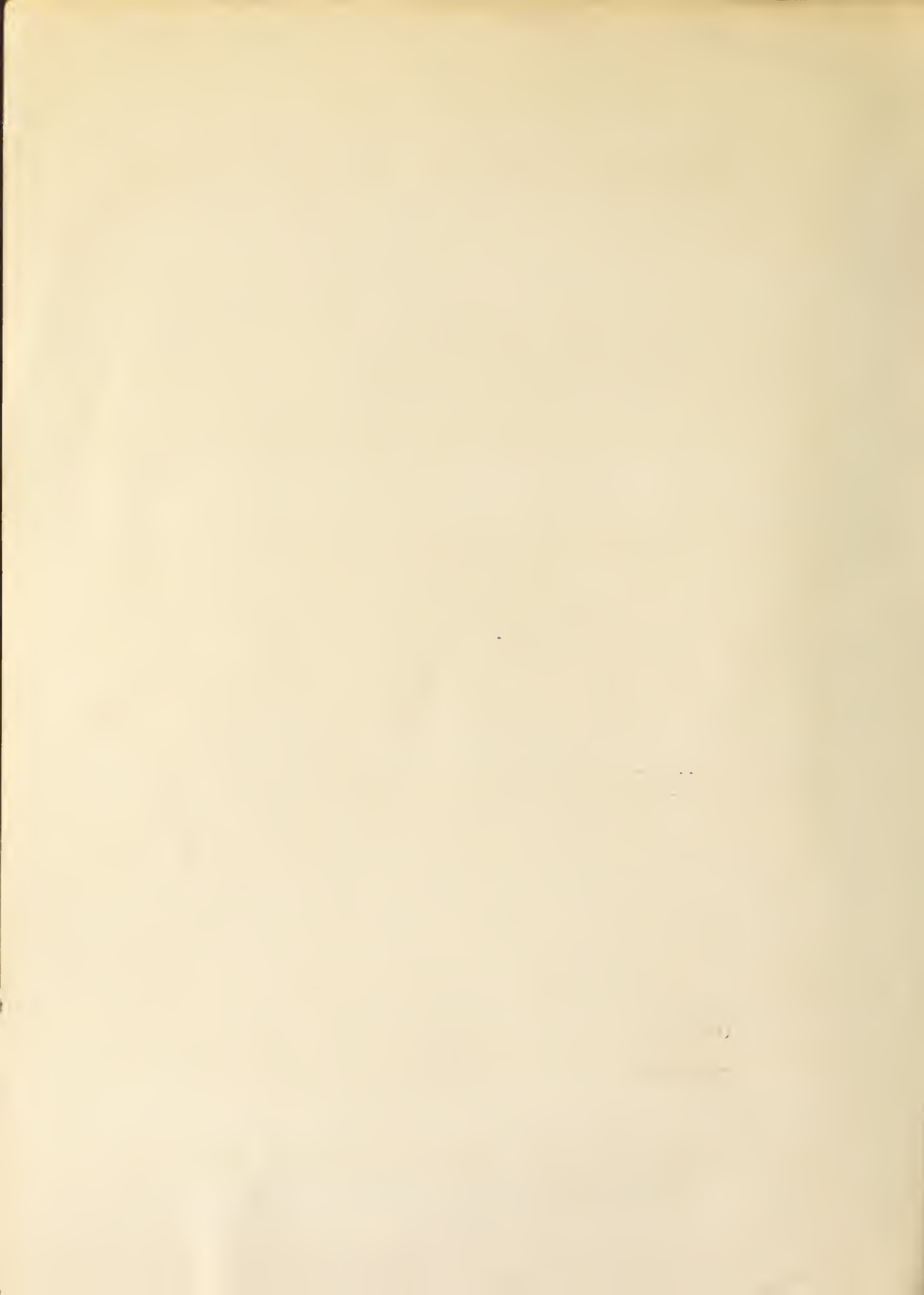
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GLUES FOR USE IN AIRCRAFT¹

The glues that are adapted for gluing wood in aircraft may conveniently be divided into five classes, as follows: (1) synthetic-resin glues, (2) casein glues, (3) blood albumin glues, (4) marine glues, and (5) miscellaneous adhesives.

Synthetic-resin and casein glues are most important for aircraft. Blood-albumin glues were formerly of importance in producing water-resistant plywood but they have been largely displaced by synthetic-resin glues. Blood albumin may be encountered, however, as a filler or extender of synthetic-resin glues². Synthetic-resin glues are used chiefly in the production of plywood. In the fabrication of other parts and in the assembly of the finished craft, casein and cold-press resin glues will find use. Marine glues are used in wooden float and hull construction but not for making joints where high strength is required.

Synthetic-resin glues are based on resins synthesized from various chemical compounds. Of the many types of synthetic resins, only two have found wide use as woodworking adhesives. Of the two, the most highly resistant to moisture is the condensation product formed by the reaction of an aldehyde (usually formaldehyde) and a phenol (usually phenol or cresol). The product of the reaction between urea and formaldehyde is not so highly resistant to all types of exposure as the phenol-aldehyde product but, in a glue line, its resistance is superior to that of casein glue and it is widely used in woodworking. In preparing these products for use as adhesives, the reaction between the chemicals is stopped at an intermediate stage in which the product may be applied on the veneer, the plies assembled, and the reaction completed under simultaneous application of heat and pressure (hot pressing). Some are applied in the form of a film, some as aqueous suspensions or solutions, and others in alcohol solution. A few are available that can be applied and pressed at room temperatures (cold pressing). These depend on the addition of a "catalyst" or "hardener" to cause the condensation reaction to proceed at room temperatures.

Casein glues are a mixture of casein and other materials (usually lime and one or more sodium salts) combined in such proportions as to dissolve the casein and produce a mixture of satisfactory properties. The casein itself is a variable product, and the use of different ingredients in varying proportions results in glues of widely

¹This mimeograph is one of a series of progress reports issued by the Forest Products Laboratory to aid the Nation's defense effort.

²Animal, vegetable, liquid, soybean, and flour-extended resin glues, which are extensively used in other wood-working industries, are not suited for aircraft work.

differing properties. A marked difference exists in water resistance -- a property of very great importance in aircraft, since only the more water-resistant glues should be used for this purpose.

Blood albumin glues are made with an albuminous base obtained from the blood of animals, combined with chemicals, such as lime, caustic soda, sodium silicate, paraformaldehyde, etc. The albumin is usually bought in dry form.

Marine glue used in aircraft construction is solely for the purpose of making hulls and floats, constructed of wood planking, water-proof. The glue, therefore, must have good adhesive qualities, remain tacky in all climates, and be of such consistency as to penetrate fabric of high thread count. In general, marine glue should contain the following ingredients: Rosin, pine tar, denatured alcohol, and a drying oil (Tung oil, rosin oil, or linseed oil), the proportions of which are left entirely to the manufacturer.

Miscellaneous adhesives. Vegetable proteins, such as soybean and peanut meal, serve as bases for adhesives, which in general properties resemble casein glues. Some of them have a good degree of water resistance, moderate dry strength, and are relatively cheap. In their present stage of development they do not quite equal the strength of the better-quality casein glues. Other materials, including cellulose cements, asphalts, gums, and rubber have been tried as adhesives for wood. In their present forms these materials are not suitable as glues for wood joints, although some of them may have possibilities of development, and an improvement in one or more respects may make their use in aircraft desirable.

Properties of glues. A comparison of synthetic resin, casein, and blood albumin glues is made in the accompanying table. It should be remembered, however, that there is a wide variation among the glues of any of these classes and that the comparison applies only to the strongest and most durable of each class.

Properties of Glues used in aircraft¹

Property or characteristic	Casein glue	Blood albumin glue	Synthetic resin glue
Strength (dry) ²	:Very high to high	:High to low	:Very high to high
Strength (wet after soaking in water 48 hours) ²	:About 25 to 50 percent of dry strength -- varies with glue	:About 50 to nearly 100 percent of dry strength	:Very high; nearly 100 percent of dry strength
Durability in 100 percent relative humidity or prolonged soaking in water	:Deteriorates eventually -- rate varies with glue	:Deteriorates slowly but usually completely in time	:Very high if resin is unadulterated
Rate of setting	:Rapid	:Very fast with heat	:Very fast with heat
Working life	:Few hours to a day	:Few to many hours	:Few to several hours for liquid forms; several weeks for films
Consistency of mixed glue	:Medium to thick; little change with temperature	:Thin to thick; little change with temperature	:Medium for liquid forms
Temperature requirements	:Unimportant	:Heat required to set most glues	:Heat required for most glue
Mixing and application	:Mixed cold with water; applied cold by hand or mechanical spreaders	:Usually mixed cold with water; applied cold by hand or mechanical spreaders	:Often applied as received or after addition of "catalyst"; liquid forms best applied by rubber-covered roller
Tendency to foam	:Slight if not mixed too rapidly	:Slight to pronounced	:Slight
Tendency to stain wood	:Pronounced with certain woods	:None, except dark glue may show through thin veneers	:None, although glue may penetrate through thin or porous veneers
Dulling effect on tools	:Moderate to pronounced	:Slight	:Moderate
Spreading capacity ⁴ Extremes reported ² Common range ²	:35 to 80 40 to 60	:30 to 100 ---	:30 to 100 35 to 50

¹Grades and quality only of glues that pass aircraft specifications.

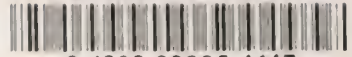
²Based chiefly on joint strength tests.

³Based on plywood strength tests.

⁴Expressed in square feet of single glue line per pound of dry glue for veneer work.

⁵Based on reports from manufacturers of various commercial products.

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